

CHAPTER 5

Manager's Summary

NO-NET-LOSS OF WETLANDS

The national “no-net-loss” policy for wetlands was adopted to counter tremendous losses of these valuable natural resources, with mitigation playing a central role in its implementation (White House Office on Environmental Policy 1993; Zedler 1996). For the purposes of this document, mitigation refers to activities related to permitted habitat conversions and includes a sequence of avoiding damage, minimizing damage, and finally, if needed, planting to compensate for damage. Compensatory mitigation usually follows the destruction of existing habitat when the agent of loss and responsible party are known. Compensation assumes that ecosystems can be made to order and, in essence, trades existing functional habitat for the promise of replacement habitat. In addition, the “no-net-loss” policy recommends increasing the quality and quantity of wetland resources through restoration of historically degraded habitats. Here the term, “restoration” does not apply to permit-associated projects, although planting techniques and assessment used may be identical.



SEAGRASS ECOSYSTEMS

Wetland resources include subtidal seagrass beds and their associated interspersed unvegetated bottom which perform a number of important ecological functions and are among the most productive ecosystems on the planet. There are at least 13 species of seagrasses in U.S. waters, with seagrasses occurring in all coastal states, with

the possible exception of Georgia and South Carolina. Conservation, mitigation, and restoration attempts have been underway for many years, and despite the wide-scale distribution and ecological importance of seagrasses, surprisingly little is known regarding some aspects of their distribution, population biology, resistance to various disturbances, and rates of recovery following disturbance.

VALUE AND FUNCTION OF SEAGRASS HABITAT

Seagrasses occur almost exclusively in shallow, soft-substrate habitats where their roots bind sediments and their canopies baffle waves and currents. Seagrasses and their associated epiphytes are highly productive, produce a structural matrix on which many other species depend, improve water quality, and stabilize sediments.

Because of their requirements for high light levels, seagrasses are restricted to shallow coastal areas where anthropogenic disturbances that damage or kill them are common. Unfortunately, once seagrasses die, the sediments they helped stabilize may be resuspended into the water column, potentially lowering light levels to intensities that may not allow seagrasses to recover in this site unless the entire watershed is managed to improve water clarity.

LOSS OF SEAGRASS HABITAT

As human population concentrates along our coastlines, anthropogenic impacts to seagrass habitats increase through nutrient loading from runoff, light reduction from increased turbidity due to phytoplankton blooms, increased boat traffic, and more direct vessel impacts such as propeller scarring.

In recent years, seagrass losses of 30% to 90% have been reported from the Chesapeake Bay and coastal areas of Texas, Florida, Washington, and California. In some cases, historic losses from disturbance and disease appear to have been even greater. Disturbances kill seagrasses rapidly while recovery is usually very slow. If the resource services that seagrass beds provide are to be maintained, lost beds need to be restored and processes harming present-day beds need to be minimized or restored through improvement of environmental conditions that facilitate recovery.

MITIGATION AS A MANAGEMENT TOOL

Recent legislation embodied in the Manguson-Stevens Fisheries Management and Conservation Act of 1996 recognizes that the long-term viability of living

marine resources depends on protection of their habitat, and requires that each of the Fishery Management Councils describe and identify essential fish habitat in fishery management plans and avoid or minimize adverse impacts to such habitat. It also requires that the Secretary of the Department of Commerce initiate and maintain research to identify essential fish habitat, the impact of wetland and estuarine degradation, and other factors affecting the abundance and availability of fish. Also required are recommendations on research needed to develop restoration techniques for these habitats. Because productivity and recruitment success may be determined at different life history stages of a fishery species, the Plans are required to describe each of these stages and their connectivity to habitats. The first amendments are due to Congress for evaluation and approval in October 1998.

Seagrasses have been recognized as one of the many habitats that are essential to conservation agencies and organizations around all coasts. Many of the management organizations have formal and/or informal policies on aspects of management of seagrass habitats. Recently the Atlantic States Marine Fisheries Commission (ASMFC), which assists in managing and conserving shared coastal fishery resources of the 15 Atlantic coastal states from Maine to Florida, established a "Submerged Aquatic Vegetation Policy". The promulgation of this policy was based on the recognition that many of the ASMFC managed species are directly dependent upon SAV for refuge, attachment, spawning, food, or prey location. Coupled with the Essential Fish Habitat component of the Magnuson-Stevens Act of 1996, seagrass meadows along the Atlantic coast and elsewhere should receive more conservation, protection and enhancement measures.

In the past, mitigation was perceived as an experimental tool rather than an established management practice. Given the documented success of mitigation, this perception is no longer appropriate. Seagrass planting is now a proven management tool. However, planting will not succeed unless managers appreciate and emphasize the extreme importance of site selection, care in planting, and incorporation of plant demography into the planting and planning process. Many planting failures have resulted from poor site selection or poor planting procedures rather than basic limitations of planting technology. When appropriate procedures are followed, planting has been relatively successful (e.g., Southern California sites). Planting of different seagrass species has been employed in a variety of habitats, using a wide range of procedures. The relative success of seagrass plantings when using different techniques, seagrass species, or habitats has often been difficult to judge rigorously because of the absence of standard assessment techniques following planting a problem common to habitat restoration in general (Mager and Thayer 1986, Race and Fonseca 1996). However, seagrass plantings that persist and generate the target acreage have been shown to quickly provide many of the functional attributes of natural beds.

SPECIAL PLANNING CONSIDERATIONS

Whether a project focuses on restoration or compensatory mitigation of an injured site, careful and thoughtful planning is crucial to project success. Managers need to determine if a seagrass system has been injured, how much area has been disturbed, and what constitutes adequate remediation. These decisions may not be as straightforward as they might seem. For seagrass beds that establish seasonally from seed banks, beds that are lush in the summer may appear as bare sand in the winter. Thus, if there is no historical or at least seasonal perspective, a manager could look at the site in the winter and conclude that no seagrasses are present and no mitigation is needed. A similar error could occur when monitoring a planted bed. If the responsible party planted a large bed that did well, set seed, and died back (as might be natural for this location and species of seagrass), mitigation might be judged to be successful if the bed were checked in the summer of establishment or during the next summer when the seed bank had germinated. If the site were checked in the winter, however, mitigation at this same site might be judged to have failed completely because only bare sand would be visible. Such instances call for more comprehensive site surveys such as coring for seeds and/or living rhizome and shoot meristems. Moreover, some beds migrate over time, meaning larger areas of the seafloor must be set aside to maintain the patchy population.

Methods of seagrass transplantation that are efficient and cost effective in one geographic region may be ineffective in another. Managers should consider the life history characteristics of local species, and how these species vary geographically, seasonally, and as a consequence of various physical (e.g., temperature) or biological (e.g., bioturbators) regimes.

PRESERVING GENETIC DIVERSITY

Continued research is needed to determine how anthropogenic actions may isolate small populations and erode genetic diversity. Managers should strive to potentially maximize genetic diversity by selecting planting stock from a variety of widely distributed seagrass beds. Collection of all planting units from one localized bed, even if that bed appears robust, may result in a high degree of relatedness among transplants; this lack of genetic diversity could depress sexual reproduction or make planted beds more uniformly susceptible to diseases or other disturbances.

Although populations are difficult to define, managers should also strive to conserve existing stock and minimize geographic isolation of seagrass beds as a long-

term management goal to maintain genetic structure of local seagrass systems. But no gene complex can provide protection against insufficient light, excessive nutrient loading, or the depredations of bioturbating organisms in a recently planted bed.

SITE SURVEYS PRIOR TO IMPACT

It is important to obtain information about seagrass distribution and the environmental conditions at a site before that site is allowed to be disturbed. If sites are illegally injured prior to being assessed, extent of damage is especially difficult to assess. Site surveys are a recommended tool but they provide inadequate information if sites are surveyed at only one point in time. This is especially true when dealing with patchy seagrass beds. It is important that managers realize that bare areas among patchy seagrass beds are a natural characteristic of these beds and that over time seagrasses will move and alternately colonize and vacate these areas. If channels are placed in these beds in such a way that they intercept bed migration, unanticipated and persistent losses of seagrass habitat may occur. If possible, present-day beds should be evaluated over a sufficient period of time and with appropriate spatial resolution to reveal seagrass movement into bare areas and identify currently unvegetated areas that should be protected from negative impacts.

IDENTIFY PROJECT GOALS

Early in the planning phase, the project manager must determine whether the project will be for compensatory mitigation or for restoration. These projects could have different goals and may be evaluated according to different performance criteria by resource agencies. In any case, attaining the same seagrass species as what was lost with a comparable shoot density and equal or greater area of bottom covered (depending on time since injury and recovery potential) that compensates for interim lost services is a logical and ecologically defensible goal.

PERMIT COORDINATION PROTOCOLS

Because different agencies at the state, federal, county, and municipal levels may have jurisdiction over projects affecting wetlands or seagrass beds, delays can be avoided by addressing all permitting requirements as far ahead of planting as possible. Coordination protocols developed for Southern California, the Chesapeake Bay, and Connecticut provide guidance. A standardized protocol is essential to accurately convey the scope of the potential injury to the public stewards and to simultaneously treat applicants in a consistent and fair manner.

INTERIM LOSS ASSESSMENT

It is essential to profile the injury area and determine the interim loss of ecosystem functions. This determination considers how much acreage will be lost and how long it will take to replace the ecosystem services that this area provides. In the past, interim loss assessment has been inconsistent, with highly variable replacement ratios. NOAA's Damage Assessment and Restoration Program is now utilizing an economically-based model to standardize interim loss computations using discounting methods and acre-years of lost services as a metric. A qualitative description of the model is provided (p. 66 and Appendix E).

SITE SURVEYS

Guidelines for pre-injury and pre-planting surveys allow managers to quantitatively profile seagrass habitat. Surveys can identify species composition, distribution, and availability of seagrass to salvage and which could then be set aside for planting to other sites or replanting to the original site in the case of short-term disturbance. Aerial photographs can establish the historical perspective on the persistence and distribution of coverage on the site. Pitfalls to seagrass habitat replacement over the long term include transplanting into unsuitable areas, or into bare areas between established seagrass patches. If aerial photographs or other surveys indicate no history of seagrass cover over a ten-year period, then the planting site should be rejected as unsuitable, unless some specific actions are taken to improve the site, or, unless mitigating factors such as recently improved water quality can be demonstrated.

SITE SELECTION

Site selection is the single most important step in the seagrass restoration and mitigation process. Important aspects of site selection and seagrass physiology include the following: emersion and desiccation effects; bioturbation; sediment thickness; sediment stability; natural recolonization; nutrient limitation or overload; light requirements and light attenuation characteristics of the site; salinity and temperature tolerances; and waves and current speed (see site selection criteria in Appendix E).

Planting areas are classified as either on-site or off-site. In some cases grading down of upland areas or engineering subtidal areas to create suitable sites may be possible. When destruction of the site requires planting in another location it is often *very difficult to find a suitable off-impact site location*. The seemingly simplistic question that must first be asked is "If seagrass does not grow there now what makes you believe it can be successfully established?" (Fredette et al. 1985).

OBTAINING TRANSPLANT STOCK

Most planting projects currently utilize wild planting stock which almost always requires a permit to collect. Managers are cautioned against repeated harvests from donor sites. Matching the environmental conditions of the donor site to the planting site remains, after 50 years (Addy 1947), the best rule of thumb for donor stock selection. In terms of long-term management, some planted beds should be created solely to provide donor stock and experimental beds no longer being studied could be made available for harvest.

Successful planting of seagrasses demands that: (1) planting units have intact meristems so that they can spread vegetatively, (2) they have enough short shoots per long shoot to facilitate growth following planting, and (3) minimization of stress to planting units so that they are healthy when planted. For seagrasses to undergo vegetative spread, they must have at least one apical meristem on a rhizome in each planting unit. Greater numbers of rhizome meristems is preferable. Spread of planting units will also be enhanced if they have several short shoots per long shoot. Minimizing stresses experienced by planting units will reduce the possibility of rhizome meristems being killed, and will facilitate more rapid establishment of transplants. To achieve this, plants need to be collected and planted soon thereafter, preferably on the same day, kept in seawater that is of ambient temperature and salinity, and not crowded or piled on each other in ways that cause bruising or breakage.

A common cause of planting failure is inexperience of persons involved in the project. Persons involved in the project need to be able to identify the species to be planted, be familiar with the handling and planting methods, and, in some cases, be comfortable snorkeling or SCUBA diving. Planting starts with selecting an appropriate area and marking it with poles or buoys so that its boundaries are visible. Waders, snorkelers, or SCUBA divers then begin planting, unless remote methods are used. As diving often increases costs considerably, it may be advisable to have workers pre-place planting units so that underwater time can be used most effectively. Previous efforts have shown that volunteers often lose interest in planting because it becomes tedious and repetitive following the brief learning period; paid staff may be more cost effective, but close attention to providing challenge and diversity in tasks is recommended.

PLANTING METHODS

Planting can be conducted using any of several methods. The *plug method* involves driving 4-6 inch diameter PVC tubes into established seagrass beds, capping

these tubes to create a vacuum that allows removal of the tube and its contents, and then transplanting this plug of seagrass, rhizomes, and sediment into a new habitat. Although this method tends to be more expensive than others, it has been extensively used with numerous species with good results. The *staple method* involves digging up plants and their associated rhizomes using a shovel, shaking sediment from the rhizomes, using twist-ties to attach rhizomes to metal, bamboo, or wooden staples, and planting these seagrasses by pushing the staples into sediments so that blades protrude upward and rhizomes are buried in the sediments. In calm areas, staples can be placed over groups of plants without securing the plants with twist-ties. This method is cost effective, widely used, and generally successful. The *peat pot method* has been used less than the above methods, but shows promise. A sod plugger is used to extract 3x3" plugs from an existing seagrass bed. These are immediately extruded into similar sized peat pots and the peat pots then transplanted into areas that are to be established. Once in the bottom, the sides of the peat pots are ripped to facilitate spread of the rhizomes. This method currently has the lowest cost per planting unit. Plants can also be collected with a shovel and plants with sediment shaped by hand into a peatpot sized mass and put into the pot for planting. *Other methods*, including sowing seeds, have also been tried. Some of these show promise and may be desirable for particular habitats or situations; however, most other methods have been used less extensively and are less well tested. Several investigators have attempted to improve planting success by adding fertilizers. These efforts have produced mixed results. At present, it appears that fertilization, and potentially, hormone treatment, cannot hurt and may improve planting success, especially phosphorus fertilization in carbonate sediments.

There is a considerable literature on how the spacing of transplants affects coalescence rates, potential disturbance in habitats subjected to different flow regimes, etc. In general, a balance will have to be achieved between desired coverage, rate of coverage, and the cost of planting at different densities or using different arrangements. Determining spacing requires knowledge of the natural history and physiology of the seagrasses being planted and an understanding of the hydrodynamics affecting the planting site. However, decreasing spacing may reduce bioturbation.

EVALUATING PROJECT SUCCESS

Seagrasses are planted in hopes of restoring all aspects of ecosystem function (sediment stabilization, nutrient cycling, etc.) that were lost when natural beds were injured. However, management resources are rarely available for monitoring planted beds to be sure that they each recover these functions. Although numerous cri-

teria have been used for evaluating planting success, studies available to date indicate that simple measures of seagrass coverage and persistence are the most parsimonious indicators of a functioning seagrass bed, and are the measures that should be favored by resource managers. Therefore, successful seagrass establishment should be defined as beds that persist, unaided, at, or above, the desired acreage with comparable shoot density for a period of five years following planting, or in the case of slow-spreading species, on a trajectory for reaching the target acreage in a specified time. Use of Habitat Equivalency Analysis is strongly recommended to help identify and utilize realistic recovery horizons.

MONITORING PLANTED BEDS

Monitoring planted beds is necessary to: (1) ensure that contracted work was performed to specifications, (2) allow for mid-course corrections, and (3) improve planning of subsequent projects. Adequate monitoring will involve determination of percent survival of planting units, the areal coverage of each planting unit, and the number of shoots per planting unit. For small plantings, these measures may be taken on each planting unit. For larger plantings, monitoring will need to be conducted using numerous randomly (as opposed to arbitrarily) located sites within the area that was planted. Specific recommendations on making these measurements, converting measurements into the most useful form, appropriate sizes of quadrats, etc. are provided. Monitoring should occur at least quarterly during the first year following planting, and biannually for at least four years after this (i.e., for a minimum of five years). If replanting is necessary, this sets the five-year-clock back to zero for the area that is replanted. This five-year rule may need to be extended in situations where seagrasses spread very slowly. If two replantings following the initial planting fail to establish a successful grass bed, then managers should abandon these failed sites or portions thereof and find areas more suitable.

INTERPRETING RESULTS

The bottom-line is that the *target acreage* must *persist* with a comparable shoot density for an adequate period of time to assure that the planted seagrasses are well established and likely to provide the desired ecosystem functions. Although various percent survivorship criteria previously have been used to define planting success, these criteria may miss the point that it is not percent survivorship alone, but coverage and persistence that are the critical components of establishing adequate seagrass systems, especially since the ultimate metric of success is generating acre-years of seagrass service (i.e., to offset interim lost resource services).

COST ESTIMATES

Costs of successfully establishing seagrass beds vary from a few thousand to many thousands of dollars per hectare depending on site selection, experience of workers and managers, extent and rate of subsequent disturbance, water clarity and depth (i.e., light availability and quality), temperature, extent of monitoring following the plantings, and numerous similar factors. Published costs for planting range from about \$25,000 to \$50,000 per hectare, with an average of about \$37,000. These general estimates likely greatly underestimate the cost of a particular project because of the particular concerns associated with each site, the size of the site, the coverage that needs to be achieved, the species of seagrass involved, special logistic costs, monitoring, and profit; the latter frequently overlooked! Values in the range of \$200K per *acre* may be more reasonable over the life of the entire project.

CONSERVATION, MITIGATION, AND RESTORATION

Despite proven techniques, the success rate of permit-linked mitigation projects remains low overall. There is continuing difficulty in translating mitigation concepts into legal principles, regulatory standards, and permit conditions that are scientifically defensible and sound. To prevent continued loss of seagrass habitat under compensatory mitigation, decisive action must be taken by placing emphasis on improving compliance, generating desired acreages, and maintaining a true baseline.

Seagrass planting is not an experimental technique. Seagrass beds can be restored but preservation is the most cost-effective course of action to sustain seagrass resources. Planting for mitigation should be treated as the last practicable alternative. There must be communication and coordination of efforts between agencies and those that would alter seagrass habitat. Seagrass beds have been recognized as a valuable resource essential to the health and function of coastal waters, and greater awareness and public education is necessary for conservation of this resource. The problems of restoring seagrass beds are largely those of appropriate site selection, plant demography, care in planting, and subsequent disturbance.

Seagrass habitat conservation must become a national focus because loss can occur rapidly when conditions are altered and because recovery occurs at a much slower rate. If an area is already stressed due to diminished water quality from point and non-point source runoff, addition of a new channel or increased boat traffic to a new marina may push the nearby seagrass population beyond its physiological limits. Once the habitat is lost, turbidity from nonstabilized sediments may make restoration impossible, with concomitant additional reduction in water quality.

As more information is made available to managers regarding the function of seagrass ecosystems and the costs involved in mitigating for their loss, fewer permitted impacts are occurring with more emphasis placed on impact avoidance and minimization. Our ability to wisely manage, conserve, or restore these productive ecosystems is limited due to our fragmentary understanding of seagrass ecology and distribution and inconsistent application of available technology. Managing seagrass systems requires that managers understand some basics of seagrass ecology and having historical perspective regarding the particular seagrass beds being affected by their management decisions. Why place such a priority on conservation if mitigation is no longer experimental? Although techniques and protocols exist that produce persistent seagrass beds, they are applied inconsistently, and have resulted in large-scale failures. Key issues to protect existing seagrass habitat include improved wastewater treatment, surface run-off control (i.e., watershed management), restrictions on certain shellfish and fish harvest methods, control of boat traffic, and public education.